MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Permitting and Compliance Division
Water Protection Bureau
P.O. Box 200901
Helena, MT 59620-0901

Permit Fact Sheet
Montana Ground Water Pollution Control System (MGWPCS)

Permittee:	WMSJ Development, Inc.
Permit No.:	MTX000203
Receiving Water:	Class I Ground Water
Facility Information	
Name:	North Canton Major Subdivision
Mailing Address:	50 Canton Lane Townsend, MT 59644
Contact:	William Duede
Phone:	406-226-5681
Fee Information	
Number of Outfalls:	1
Outfall - Type:	001 Drainfield

I. Permit Status

This is a new permit for a proposed wastewater treatment system that is part of a subdivision located in Townsend, MT. The Department received the initial permit application and supporting documents from Stahly Engineering and Associates Inc (SEA) on June 20, 2007. The application was determined to be deficient on July 11, 2007 and again on September 4, 2007. The Department received responses to the deficiency letters on August 6, 2007 and September 4, 2007 October 30, 2007. A complete permit application was received and the permit application was deemed complete on November 13, 2007.

II. Facility Information

A. Facility Description

The North Canton Major Subdivision (NCMS) has estimated an average volume of discharged wastewater at approximately 36,250 gallons per day from a 145 dwelling unit subdivision. The applicant reported a maximum daily design flow for the treatment system of 55,000 gallons per day. The applicant applied for and received a deviation from the standard 300 gallons per day (gpd) wastewater flow volume to 250 gpd. Based on 145 dwelling units, this would allow the applicant a daily maximum design flow of 36,250 gpd. Wastewater from each lot will be collected in individual 1,500 gallon onsite septic tanks. These septic tanks will provide primary treatment. Small diameter (2-3 inch) force mains will transport effluent from the septic tanks to the treatment system. The initial components of the wastewater treatment system (WWTS) are a 30,000 and a 25,000 gallon fiberglass tanks connected in series to function as a recirculation tank. After treatment in the recirculation tanks effluent will be sent to 1 of 9 Advantex treatment pods. Treatment pods consist of textile filter media capable of treating up to 5,000 gpd of residential strength waste water (SEA 2007). A splitter valve diverts 80% of the filtered effluent back to the recirculation tank for further treatment and 20% of the filtered effluent to the drainfield dosing vault. From this point effluent will be sent to a 4,000 gallon drainfield dose tank which will dose Outfall 001 (Figure 1).

The proposed wastewater treatment facility will discharge via 1 Outfall. The drainfield is one large drainfield, comprised of 3 zones and will be Outfall 001. This drainfield is located on the hydraulically up gradient side of the NCMS. Outfall 001 is situated in T7N, R2E, in the northeast ¼ of the southeast ¼ of the southwest ¼ of Section 29, or N 46º 19’ 37.8” latitude and W 111º 30’ 39.9” longitude.

B. Effluent Characteristics

The wastewater treatment system is a new system therefore no effluent samples have been collected or analyzed. However, the applicant has submitted effluent data from two similar wastewater treatment system located in Montana. Average effluent characteristics of similar ADVANTEX treatment pods incorporating textile filter media are listed in table 1.

Table 1 Effluent Characteristics

Parameter	Units	Average
Total Suspended Solids (TSS)	mg/L	10
Biological Oxygen Demand (BOD_5)	mg/L	7.8
Total Coliform	mpn/100 ml	1
Total Ammonia, as N	mg/l	3.1
Total Kjeldahl Nitrogen, as N	mg/L	5.5
Nitrate + Nitrite, as N	mg/L	11.34
Total Nitrogen	mg/L	16.84
Total Phosphorous, as P	mg/L	0.12

III. Proposed Technology Based Effluent Limits

A level II system must provide at least a 60 % removal of total nitrogen in raw wastewater or produce effluent with a total nitrogen concentration of 24 mg/L or less [ARM 17.30.702 (11)]. The Department will use 24 mg/L as an effluent limit because of the inability to get reliable estimates of 60 percent removal of total nitrogen from a wastewater treatment system incorporating individual septic tanks at each residence. A 60 percent removal rate would have to be calculated for the entire treatment system. A sampling and analysis plan for determining a 60 percent removal rate was not outlined in the permit application. Therefore a value of 24 mg/L will be used as a permit effluent limit. Because an additional 7% of nitrogen removal is assumed to occur within the drainfield a proposed limit of 26 mg/L will be used. The technology-based permit limit for total nitrogen will be set at 26 mg/L (see Table 1).

The proposed technology based effluent limits for Outfall 001 are presented in Table 1.

Table 2. Technology Based Effluent Limit for Outfall 001

Parameter	Concentration (mg/L) Daily Maximum (1)
Total Nitrogen as N	26

(1) See definitions, Part I.A of the permit

IV. Water-Quality Based Effluent Limits

A. Receiving Water

The permittee submitted ground water analytical data from wells around the wastewater treatment system. All ground water quality data used in development of permit conditions is sourced from wells that are located within one mile of the discharge site.

Ground water quality sampling was conducted from up gradient and down gradient monitoring wells. Four monitoring wells were installed and sampled to assess ground water quality. All four of the monitoring wells are located on site. All water quality sampling occurred on site prior to construction of the WWTS and discharge of effluent to state waters.

The applicant submitted ground water analytical data from the four onsite wells and one on site test well. Sampling was conducted in October 2006, January 2007, May 2007 and July 2007.

Table 3. Ground Water Monitoring Results or the Receiving Water Quality

Test	Units	Minimum Value	Maximum Value	Average Value	No. of Samples
Specific Conductivity	umho/cm	458	654	566	6
Total Dissolved Solids	mg/L	255	407	340	6
pH	s.u	7.5	7.9	7.7	6
Chloride	mg/L	12	18	14	6
Escherichia Coli	No/100 ml	ND(1)	<2	<2	6
Total Kjeldahl Nitrogen	mg/L	ND(1)	0.8	0.3	6
Nitrate + Nitrite	mg/L	ND(1)	0.99	0.39	6
Total Organic Carbon	mg/L	ND(1)	6.9	1.33	6
Total Nitrogen	mg/L	0.7	1.8	1.1	4

(1) ND= Non Detect

Sampling yielded specific conductivity values of between 454 and 654 umho/cm. Therefore, the receiving water for Outfall 001 is Class I ground water as defined by the Administrative Rules of Montana [ARM 17.30.1006 (1)(a)] (ground water with specific conductance equal to or less than 1,000 microSiemens/cm). Class I ground water is to be maintained for the following beneficial uses with little or no treatment: public and private water supplies, culinary and food processing purposes, irrigation, drinking water for livestock and wildlife and for industrial and commercial uses. Water quality human health standards (DEQ-7, February 2006) apply to concentrations of substances in Class I ground waters. Pursuant to ARM 17.30.1006(1)(b)(ii) for parameters that are not listed in DEQ-7, there shall be no increase in Class I receiving water concentrations to levels that render the water harmful, detrimental or injurious to the beneficial uses listed for Class I waters. The Department may use any credible information to determine these levels. Class I ground waters are considered high quality waters and are subject to Montana's Nondegradation Policy [75-5-303, Montana Code Annotated (MCA)].

Application materials gave hydraulic conductivity values ranging from 168 ft/day to 936 ft/day. These estimates were derived from tests conducted in wells on the NCMS site (wells 1-4 with the aid of observation wells 5-7). Well tests were conducted in the shallow aquifer approximately 40-50 ft. The well tests were conducted during preliminary site characterization of the subdivision. This value is representative of the sands and gravels that comprise the first aquifer. The hydraulic gradient in the shallow ground water was reported as 0.00035 ft/ft, estimated from 4 onsite monitoring wells (Wells 1,2,3,4). Hydraulic gradient was established during the October 2006 ground water investigation.

The National Resources Conservation Service (NRCS) indicates that soils in the vicinity of the wastewater treatment system are comprised of 88.3 % Villy silty clay loam (0-7 inches Silty clay loam, 7-40 inches Silty clay loam, 40-60 inches Silty clay loam), 10.1% Scarvo cobbly loam (0-6 inches Cobbly loam, 6-17 inches Very gravelly sandy loam, 17-60 inches Very gravelly loamy

sand), and 1.6% Ustic Torriorthents saline (0-8 inches Loam, 8-60 inches Stratified fine sandy loam to clay loam).

Based on proximity, the nearest surface waters are the Deep Creek Overflow and Montana ditch. The Deep Creek Overflow and Montana ditches are approximately 1,600 ft and 1,800 ft (respectively) east and upgradient of the proposed discharge location and across gradient. The Missouri River Overflow and the Missouri River channel are approximately 2,000 ft and 3,600 ft respectively, northwest and down gradient of the proposed wastewater treatment system. Therefore, based on the direction of ground water flow, the nearest surface water to Outfalls 001 is the Missouri River Overflow approximately 2,000 feet down gradient. The ground water flow direction in the vicinity of the drainfield is approximately N17°W based on the 2006 ground water assessment.

B. Basis for Water Quality Based Effluent Limits

ARM 17.30.506 (1) states that a discharge to state waters shall not cause a violation of a water quality standard outside a Department authorized mixing zone. Ground water quality standards for nitrogen apply at the down gradient mixing zone boundary in the unconfined aquifer.

Water quality based limitations must be established in permits to control all pollutant or pollutant parameters that are or may be discharged at a level which will cause, have reasonable potential to cause or contribute to an excursion above any state water quality standard. The permittee must comply with the permit developed by the Department in accordance with the Montana Numeric Water Quality Standards included in Circular DEQ-7 (February 2006) and protection of beneficial uses (ARM 17.30.1006). Ground water quality standards may be exceeded within a Department authorized mixing zone (ARM 17.30.1005), provided that all existing and future beneficial uses of state waters are protected [ARM 17.30.506 (1)].

C. Nitrate

Class I ground water is considered high quality water and is subject to Montana's Nondegradation Policy 17.30 subchapter 7. The wastewater system is considered a new or increased source pursuant to ARM 17.30.702 (18) (a). Total nitrogen is the sum of inorganic nitrogen and organic nitrogen concentration [Nitrate + nitrite as N (NO_3+NO_2-N) plus ammonia and organic nitrogen as N]. The Department assumes all the nitrogen discharged to the drainfield in the effluent is converted to nitrate as nitrogen. The allowable discharge concentration is derived from the mass balance water quality equation, which considers dilution and background concentration of the receiving water (EPA, 2000).

$$C_2 = \frac{C_3 (Q_1 + Q_2) - C_1 Q_1}{Q_2}$$

C_1= ambient ground water (background) concentration, mg/L
C_2 = allowable discharge concentration, mg/*L*
C_3 = ground water concentration limit for pollutant (from Circular DEQ-7 February 2006 or other appropriate water quality standard) at the end of the mixing zone.
Q_1 = ground water volume (ft^3 / day)
Q_2 = maximum flow of discharge (design capacity of system in ft^3 / day)

The volume of ground water that will mix with the discharge (Q_1) is estimated using Darcy's equation: $Q_1 = K\ I\ A$.

Where: Q_1 = ground water flow volume (ft^3/day)
K = hydraulic conductivity (ft/day)
I = hydraulic gradient (ft/ft)
A = cross-sectional area (ft^2) of flow at the down-gradient boundary of a standard 500-foot mixing zone.

$$(Q_1) = (168\ ft/day)(0.00035\ ft/ft)(18{,}000 ft^2)$$
$$Q_{1\text{-}001} = 10{,}584\ ft^3/day$$

The allowed design flow for the wastewater disposal system is 36,250 gpd, or 4,846 ft^3/day. Hydraulic conductivity (K) of the alluvium is estimated at 168 feet per day (ft/d). The gradient was calculated by the applicant based on well data from wells surrounding the site, at 0.00035 ft/ft. The area (A) is calculated by the width of the source perpendicular to the ground water flow direction, times a depth to of 15 feet. The applicable water quality standard of 7.5 mg/L must be met at the end of the mixing zone. The permit application indicated an ambient Nitrate plus Nitrite concentration of 0.99 mg/L in the ground water. Therefore a concentration of nitrate plus nitrite of 1.0 mg/L was used in calculating the allowable nitrogen concentration at the end of the mixing zone. It is assumed that the entire total nitrogen load in the seepage effluent converts to nitrate and enters the ground water.

$$C_2 = \frac{7.5\ mg/L\ (10{,}584\ ft^3/day + 4{,}846\ ft^3/day) - (1.0\ mg/L)\ (10{,}584\ ft^3/day)}{(4{,}846\ ft^3/day)}$$

$$= 21.7\ mg/L$$

The projected daily maximum concentration of the total nitrogen in the effluent discharged to groundwater must not exceed 18.9 mg/L at Outfall 001 and 002. The Department assumes an additional 7% nitrogen removal occurs within the drainfield providing a final total nitrogen concentration discharged to ground water of 23.2 mg/L. These effluent limits ensure the nitrate plus nitrite (as N) concentration at the end of the ground water mixing zones are at or below the nondegradation significance criterion of 7.5 mg/L.

D. Phosphorus

Phosphorus is removed mainly through soil sorption processes, which vary based on soil composition. The 50-year breakthrough nondegradation criterion is based on the amount of soil available to adsorb the average load of phosphorus from the wastewater source, between the discharge point and the closest downgradient surface water. The total phosphorus limitations are imposed to ensure that the quality of the effluent meets the nondegradation limit prior to discharge into any surface water [ARM 17.30.715(1)(e)]. The effluent limits do not include a concentration limit for phosphorus because of the method used to determine compliance with the 50-year breakthrough criteria. Phosphorous breakthrough analysis calculations are mass based, therefore the limit will be a load based discharge limit.

Conducting a phosphorous breakthrough analysis of each drainfield is a less conservative means of calculating the effects of phosphorous to state waters. Due to the proximity and orientation of the drainfeilds the Department assumes all drainfields are one for the purpose of calculating phosphorous breakthrough. Using the distance to surface water (Missouri River Overflow) approximately 2,000 feet down gradient of the proposed drainfields the breakthrough time for phosphorus is 53.4 years. This breakthrough time is considered nonsignificant pursuant to Montana's Nondegradation criteria [ARM 17.30.715(1)(e)].

A phosphorous breakthrough would occur in 50 years (the level of significant degradation) at an effluent concentration of 7.06 mg/ L and load of 2.13 lbs/day or 779 lbs/year. Therefore the effluent limit for the Total Phosphorous load discharged to the drainfield shall not exceed 2.13 lbs/day or 779 lbs/year for Outfall 001. The water quality based effluent limit for Outfall 001 will therefore be set at 2.13 lb/day.

The water quality based effluent limits for Outfall 001 are presented on Table 3.

E. Escherichia Coli

The systematic dosing of the drainfield and the soil matrix of the drainfield provide natural disinfection, which will enable the DEQ-7 human health standard of <1 organism/100 ml to be achieved in the groundwater. Pathogen transport research indicates a 3-log decrease in pathogens for every meter of horizontal movement through the vadose zone and a 6-log decrease in pathogen transport for every 20 m in vertical transport through the saturated zone (Woessner, 1998). The proposed system discharges the effluent about 3 m above the ground water. A 3-log removal in the vadose zone indicates less than 1 colony per 100 ml within 3-feet of the discharge. A Mixing Zone will not be granted for pathogens.

An Escherichia Coli (E coli) limit has not been established in this permit due to the following site-specific criteria:

- The drainfield is pressured-dosed, which minimizes saturated conditions and therefore maximizes the die-off rate in natural sediments.
- The permittee is required to meet the E Coli ground water standard of less than 1 organism/100 ml at the end of the mixing zone.

The proposed water quality and nondegradation effluent limits for Outfall 001 are presented in Table 3.

Table 3. Water-Quality Based Effluent and Nondegradation Limits Outfall 001

Parameter	Concentration (mg/L) Daily Maximum (1)	90 Day Average Load (2) (lbs/ per day)
Total Nitrogen as N	23.2	7.01
Total Phosphorus as P	7.06	2.13

(1) See definitions, Part I.A of the permit

(2) load calculation: lb/d = (mg/L) x flow (gpd) x 8.34 x 10^{-6}

F. Effluent Flow

The permittee submitted technical information indicating a design capacity of 36,250. The design flow is the peak flow (daily or instantaneous) for sizing hydraulic facilities, such as pumps, piping, storage and adsorption systems and means the average daily flow for sizing other treatment systems. This value is used in calculations for phosphorous load limits and for calculations for determining the allowable nitrogen concentration at the end of the mixing zone. The flow from Outfall 001 shall not exceed the design capacity of 36,250 gpd based on the daily maximum.

G. Mixing Zone

The drainfield discharges to ground water and qualifies for a standard mixing zone for nitrogen [ARM 17.30.517 (1)(b)]. The permittee discharges all wastewater from the treatment works to Outfall 001 and will be granted a standard 500-foot ground water mixing zone in a N17°W direction. Groundwater flow direction was established via data collected from monitoring wells on-site. The shape of the mixing zone is determined from the drainfield dimensions, ground water table elevation, and groundwater flow direction, information of which was submitted with the permit application.

The permittee must comply with the ground water mixing zone rules pursuant to ARM 17.30 Subchapter 5. Ground water standards for nitrate may be exceeded within the mixing zone provided that all existing and future beneficial uses of the state waters are protected (ARM 17.30.1005).

The concentration of Nitrate must not exceed 7.5 mg/l at the down gradient boundary of the mixing zone [ARM 17.30.715(1)(d)(iii)]. The permittee will be required to comply with the all applicable ground water quality standards.

V. Final Effluent Limits

The final proposed effluent limit of 20.2 mg/L for nitrogen is water quality based. The 3.25 lbs/day effluent limit for phosphorus is a water quality based on the nondegradation significance criteria. The water quality based effluent load limit considers the assimilative capacity of the soil system to estimate the maximum load of phosphorus discharged to the groundwater without exceeding the 50-year breakthrough. The 90 day average loads limit will provide protection for surface and groundwater.

Table 4. Numeric Effluent Limits for Outfall 001

Parameter	Concentration (mg/L) Daily Maximum (1)	90 Day Average Load(2) (lbs/ per day)
Total Nitrogen as N	23.2	7.01
Total Phosphorus as P	7.06	2.13(2)

(1) See definitions, Part I.A of the permit
(2) 90 day average load calculation: lb/d = (mg/L) x flow (gpd) x 8.34 x 10^{-6}
NA = Not Applicable

VI. Monitoring Requirements

Effluent monitoring is essential to ensure the effective treatment and consistency of the wastewater discharged from the facility. Effluent limits are established to protect the ground water from a change in water quality that would cause degradation ARM 17.30.715 or limit a beneficial use [ARM 17.30.1006(1)(a)]. Samples or measurements shall be representative of the volume and nature of the monitored discharge. Water quality monitoring of the effluent shall occur from the dosing tank prior to discharge into the drainfields. Effluent samples will be a composite sample collected from all dosing tanks over a 24 hour period.

The effluent flow measurement method shall be either by flow meter and recorder or a totalizing flow meter; dose counts or pump run-times will not be accepted. Flow measurement equipment must have the ability to report a daily maximum flow. To ensure that the Total phosphorous load is calculated correctly, an accurate daily discharge must be measured. Daily discharge shall be measured when required sampling is conducted (flow measurement must correspond to sample collection to calculate an accurate load). The effluent flow rate is to be a measured and reported as a daily maximum flow and the 30 day average flow in gallons/day.

The permittee shall monitor the effluent for the constituents in Table 5 at the frequency and with the type of measurement indicated. If no discharge occurs during the entire monitoring period, it shall be stated in a Discharge Monitoring Report that no discharge occurred.

Table 5. Outfall 001 Parameters Monitored in the Effluent Prior to Discharge to the Drainfield

Parameter	Frequency	Sample Type[1]
Effluent Flow Rate, gpd[2] [3]	Daily[1]	Continuous[1]
Biological Oxygen Demand (BOD_5), mg/L	Quarterly	Composite
Total Kjeldahl Nitrogen (TKN), mg/L	Monthly	Composite
NO_3+NO_2 as N, mg/L	Monthly	Composite
Total Phosphorus (as P), mg/L	Monthly	Composite
Total Suspended Solids (TSS) mg/L	Quarterly	Composite
Total Nitrogen (as N), mg/L	Monthly	Calculated
Total Nitrogen (as N), lb/d	Monthly	Calculated
Total Phosphorus (as P), lb/d	Monthly	Calculated
Chloride, mg/L	Quarterly	Composite

(1) See definitions, Part I.A of the permit
(2) If no discharge occurs during the reporting period, "no discharge" shall be recorded on the DMR report form
(3) Permittee is to report the daily maximum and 30 day average

A. Ground Water Monitoring

Pursuant to 17.30.1031, all issued MGWPCS permits must contain special conditions which will assure compliance with the ground water quality standards. These special conditions include, but are not limited to, the self monitoring requirements for each discharge, monitoring well configuration, pollutants to be monitored, frequency of monitoring, recording and reporting and analytical methods to be utilized by the permittee.

The permittee must comply with the ground water mixing zone rules pursuant to ARM 17.30 Subchapter 5. Ground water standards for nitrate may be exceeded within the mixing zone provided that all existing and future beneficial uses of the state waters are protected (ARM 17.30.1005). The concentration of Nitrate must not exceed 7.5 mg/l on the down gradient boundary of the mixing zone [ARM 17.30.715(1)(d)(iii)].

Ground water monitoring will be required in this permit due to the following site-specific criteria:

- This area is experiencing rapid growth and development.
- Proximity of the water table to the surface (15-20 ft below the surface).
- The shallow aquifer is a coarse grained alluvial aquifer with a relatively high hydraulic conductivity.
- The need to distinguish the effects to ground water of the discharging wastewater treatment system.

To ensure that these requirements are met, the permittee will be required to monitor ground water for those parameters in Table 6.

Table 6. Monitoring Parameters for Monitoring Well:

Parameter	Frequency	Sample Type (1)
Static Water Level (SWL) (feet below the casing top)	Quarterly	Instantaneous
Specific Conductance, µmhos/cm	Quarterly	Grab
Chloride, mg/L	Quarterly	Grab
Escherichia Coli (Organisms/100 m*l*)	Quarterly	Grab
Total Kjeldahl Nitrogen (TKN), mg/L	Quarterly	Grab
NO_3+NO_2 as N, mg/L	Quarterly	Grab

(1) See definitions, Part I.A of this permit

VII. Nonsignificance Determination

During the development of the existing permit the Department determined that the discharge constitutes a new or increased source and is subject to Montana Nondegradation Policy (75-5-303, MCA; ARM 17.30.702(16)). Nitrogen concentrations are predicted to be less than 7.5 mg/L (DEQ nitrate sensitivity analysis 2008). Phosphorus load limits are based on nondegradation significance criteria for 50-year break-through to surface water in accordance with ARM 17.30.715(1)(e) (DEQ phosphorous break through analysis 2008). The Department has determined this discharge to be nonsignificant with respect to nitrogen and phosphorous concentrations at the end of the mixing zone.

VIII. Special Conditions/Compliance Schedules

a) Effluent Flow Measurement

To ensure that the total phosphorous load is calculated correctly, an accurate daily discharge must be measured. Effluent flow shall be monitored following treatment in the Advantex treatment pods and prior to discharge into the drainfield as described in section VI. Effluent flow monitoring shall begin upon the effective date of the permit.

b) Monitoring Well Installation

The permittee must monitor a minimum of one ground water monitoring well. This well shall be located in the center line of the down-gradient edge of the standard 500-foot mixing zone of Outfall 001. Within 90 days of the effective date of the permit the permittee shall submit to the Department for approval a plan for compliance ground water monitoring well installation as well as a brief summary of a monitoring, sampling and analysis plan for monitoring wells installed onsite. The plan is to include the location, conceptual design and construction methods of the planned ground water monitoring wells, and the monitoring, sampling and analysis methods that will be used to meet the monitoring required in the Permit. Prior to discharge the permittee shall submit to the Department a brief report or letter documenting the results of the monitoring well installation including the final location of the installed monitoring well, construction details (well log) for the well and a report on ground water quality in the well (see Table 7).

Ground water quality analysis shall include those parameters listed in Table 6. Ground water quality monitoring shall begin upon installation of the well and continue though the duration of the permit.

Table 7. Compliance Schedule

Time Frame	Point of Compliance
Within 90 days of the effective date of the permit	• Submit to the Department a plan for compliance ground water monitoring well installation, a brief summary of a monitoring, sampling and analysis plan for monitoring wells.
Prior to discharge	• Install monitoring well • Begin groundwater quality monitoring • Submit to the Department brief report or letter documenting the results of the monitoring well installation including construction details (well log) and ground water quality data

IX. Information Source

In the development of the effluent limitations, monitoring requirements and special conditions for the draft permit, the following information sources were used to establish the basis of the draft permit and are hereby referenced:

ARM Title 17, Chapter 30, Sub-chapter 5 - Mixing Zones in Surface and Ground Water, September 1999.

ARM Title 17, Chapter 30, Sub-chapter 7 - Nondegradation of Water Quality, March 2000.

ARM Title 17, Chapter 30, Sub-chapter 10 - Montana Ground Water Pollution Control System (MGWPCS), March 2002

Environmental Protection Agency, U.S. EPA NPDES Permit Writers Manual, December 1996

Environmental Protection Agency, U.S. EPA Wastewater Technology Fact Sheet, Package Plants, EPA 832-F-00-016 September 2000.

Environmental Protection Agency, Design Manual: Onsite Wastewater Treatment System Manual. EPA 625/R-00/008, 2002.

Fetter, C.W., Applied Hydrogeology., 1988

Regensburger, E. Nutrient-Reducing Wastewater Treatment System Designation Form. Montana Department of Environmental Quality. 2004

Stahly Engineering and Associates Inc., State of Montana Ground Water Discharge Permit Application. 2007

Woessner, W., Thomas, Troy., Ball, Pat and DeBorde, Dan C., (April 1998), Virus Transport in the Capture Zone of a Well Penetrating a High Hydraulic Conductivity Aquifer Containing a Preferential Flow Zone: Challenges to Natural Disinfection. , University of Montana., Missoula, Montana.

United States Department of Agriculture, Natural Resource Conversation Service, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx .

Prepared By: Louis Volpe December 19, 2007

Figure 1